MOMA
Multi-wavelength Observations and Modelling of Aurora

Context : The mechanisms behind the formation of auroras in the polar regions of Earth have intrigued scientists for a long time. A large fraction of the energy flowing from the solar wind to the

Earth is channelled through the Earth's magnetosphere to the polar ionosphere, where it manifests

itself in the phenomenon of the aurora or "polar lights". Auroras have also been observed from all the magnetized planets in the solar system with different characteristics from Earth since their atmosphere and magnetosphere are different, but the fundamental plasma processes behind the formation of the aurora are universal. Therefore, studying them is a key to a better understanding of related processes in solar system and even cosmic plasmas. By studying auroral physics we also obtain a better understanding of near-Earth space, and this is for example important for our ability to protect ourselves against space weather hazards.

Objectives : This project aimed at improving our understanding of auroral acceleration and associated electrodynamic phenomena through multi-wavelength observations and models. The project team will model the entire auroral chain in the Earth's magnetosphere-ionosphere system and explain the observations over a large range of wavelengths from the UV and optical spectra to radio wavelengths. Four objectives were planned :

- use ground-based optical measurements with the ALIS auroral network to obtain two-dimensional energy fluxes of precipitating electrons, which are subsequently used to characterize remotely the properties of the magnetospheric generator
- use FUV observations from IMAGE to reach various goals: 1) use proton aurora observations in combination with superDARN radar data to estimate the location of the open-closed field line boundary, the open geomagnetic flux and the reconnection voltage at the dayside magnetopause and in the magnetotail, 2) upgrade the software to measure the same quantities using images of electron aurora, 3) compare FUV imaging with EUV remote sensing of the plasmasphere
- To model the whole auroral circuit in the Earth's magnetosphere-ionosphere system in a self-consistent way.
- To develop an electromagnetic Vlasov simulation code able to model AKR emissions

Conclusions : During this project, objectives 1 and 2 described above have been investigated in detail resulting in a number of publications, presentations in international conferences and the PhD thesis of Dr. Jessy Matar. Two more publications will be submitted in 2022. The coupling of the MC model of the ionosphere (developed at LPAP) with the Vlasov code used to describe the Magnetosphere-Ionosphere coupling is still under way in order to fully model the complete auroral circuit. Due to the unexpected departure of a collaborator at BIRA-IASB, the modelling of AKR emission could not be carried out. Instead, investigations of the polarization of the auroral emissions have been conducted, a topic in which BIRA-IASB has been very active in the last years and completely relevant to the general topic of this project. In summary, the project was a success and collaborations between the two teams will continue in the coming years, e.g. in the frame of the SMILE mission.

Keywords : AURORA - MULTI-WAVELENGTH OBSERVATIONS – MODELLING – MAGNETOSPHERE – IONOSPHERE